MICROCOPY RESOLUTION TEST CHART
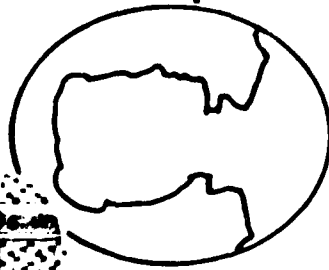
NATIONAL BUREAU OF STANDARDS-1963-A

MAY 1984

Ada® Training Curriculum

Software Engineering For Managers
M101
Teachers' Exercise Guide

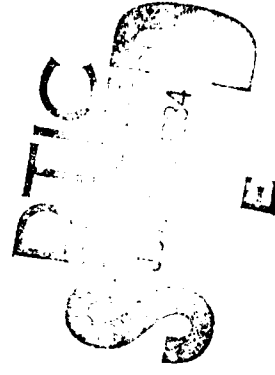AD–A142 429

Prepared By:

SOFTECH, INC.
460 Totten Pond Road
Waltham, MA 02154

Center For Tactical Computer Systems
(CENTACS)

U.S. Army Communications-Electronics Command
(CECOM)

Contract DAAB07-83-C-K514

84 06 21 112

DTIC FILE COPY
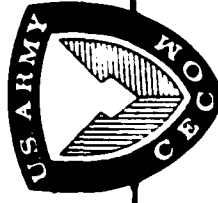
*Ada is a registered trademark of the U.S. Government, Ada Joint Program Office

EXERCISE 1

M101 - EXERCISE 1
INSTRUCTOR'S GUIDE

PURPOSE:

THE EXERCISE IS DESIGNED TO ILLUSTRATE THE USE OF THE ENGINEERING GOALS AND PRINCIPLES THAT WE HAVE BEEN DISCUSSING.

THE CLASS IS SPLIT INTO FOUR GROUPS: THREE WITH SPECIFIC GOALS STATED IN THE EXERCISE, A FOURTH WITH NO EXPLICIT GOALS. EACH OF THE THREE GROUPS HAS A DIFFERENT GOAL AS FOLLOWS:

- THE USER MUST <u>NEVER</u> FAIL TO BUILD THE OBJECT, USING THE DOCUMENTATION (RELIABILITY)
- THE USER MUST BUILD THE OBJECT WITHIN ONE MINUTE, USING THE DOCUMENTATION (PERFORMANCE)
- ONCE BUILT, THE USER MUST BE ABLE TO TEAR DOWN AND STORE THE PIECES, SO THE OBJECT CAN BE REBUILT LATER (MAINTAINABILITY)

THE EXERCISE IS DESIGNED TO ALLOW THE STUDENT TO DISCOVER AND EXPERIENCE THE WAYS IN WHICH DIFFERING GOALS CAN CHANGE THE RESULTING SOFTWARE. OF COURSE, THE VIEWGRAPH PROCEDURAL DOCUMENTATION IS ANALOGOUS TO SOFTWARE (I.E. CODE). (IF A GROUP FINISHES EARLY, HAVE THEM EXPLAIN THEIR PROCESS OF DEVELOPMENT ON A SLIDE -- THIS GROUP SHOULD THEN PRESENT LAST.)

VG 742/IE-1

PROCEDURE:

EXERCISE IS BROKEN INTO THREE PHASES: STUDENT PREPARATION, STUDENT PRESENTATIONS, AND DISCUSSION/WRAP-UP.

ALLOW TIME AS FOLLOWS:

PREPARATION   -   30-40 MINUTES
PRESENTATION   -   20-30 MINUTES (5 MIN/GROUP)
DISCUSSION   -   10 MINUTES

MAKE SURE THE CLASS IS NOT AWARE OF ANY DIFFERENCES IN THE EXERCISE HANDOUTS OR THE GROUPS. ALSO, DO NOT TELL THEM THE PURPOSE OF THE EXERCISE UNTIL THE DISCUSSION/WRAP-UP.

ONLY AFTER THE CLASS HAS SPLIT INTO FOUR GROUPS SHOULD THE EXERCISES BE PASSED OUT. ASK THE CLASS TO READ THE INSTRUCTIONS AND HOLD QUESTIONS UNTIL AN INSTRUCTOR GETS TO THE GROUP.

IF A GROUP IS HAVING DIFFICULTY STARTING, GIVE THEM A FEW HINTS.

EACH GROUP SHOULD HAVE THE FOLLOWING: EXERCISE HANDOUT FOR EACH PARTICIPANT, SCRATCH PAPER, BLANK VIEWGRAPHS, VIEWGRAPH PEN, WET NAPKINS (FOR VIEWGRAPH ERRORS).

WHAT THE STUDENTS SEE:

THE FIRST TWO PAGES ARE THE SAME, THE THIRD PAGE VARIES FOR EACH GROUP. NOTE THAT
THE GOALS ARE NOT NAMED BUT THEIR PURPOSE IS STATED.

SEE ATTACHED SLIDES FOR STUDENT COPIES ...

EXTRA BLANK PAGES AT THE END ARE FOR STUDENT NOTES.

EXERCISE (PAGE 1 - EACH GROUP HAS THIS)

DEVELOP, WITH PICTURES AND WORDS, A DESCRIPTION FOR BUILDING THE FOLLOWING SYSTEM:

FIGURE A.

VG 742/IE-4
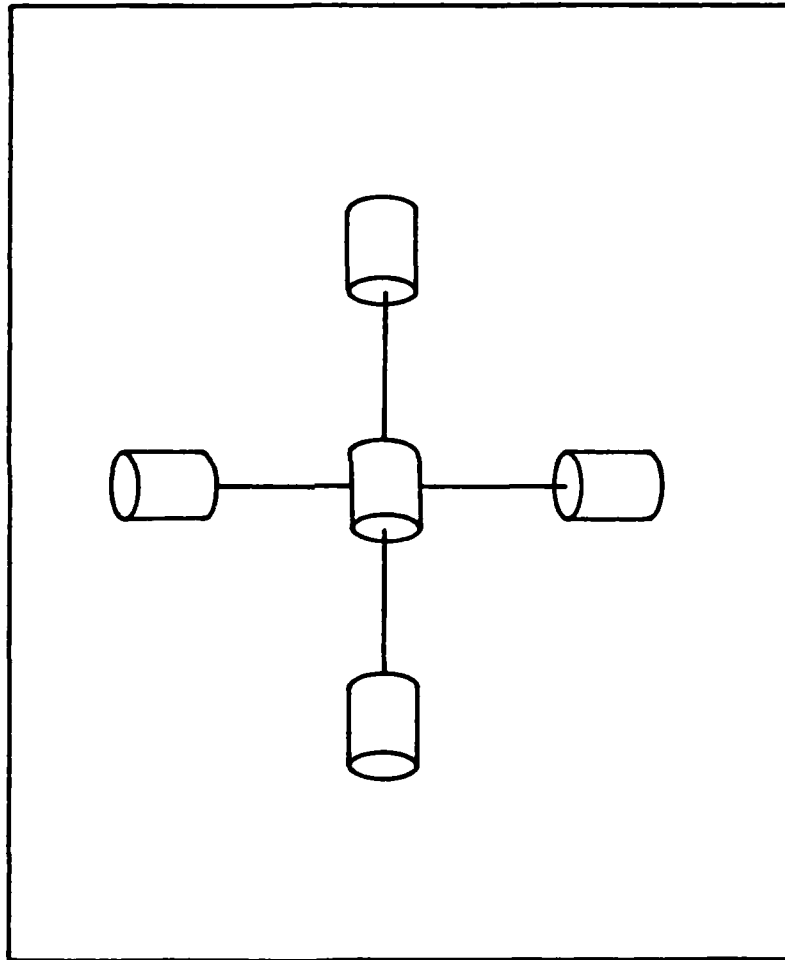
EXERCISE (PAGE 2 - EACH GROUP HAS THIS)

WITH THE FOLLOWING PARTS:

FIGURE B.

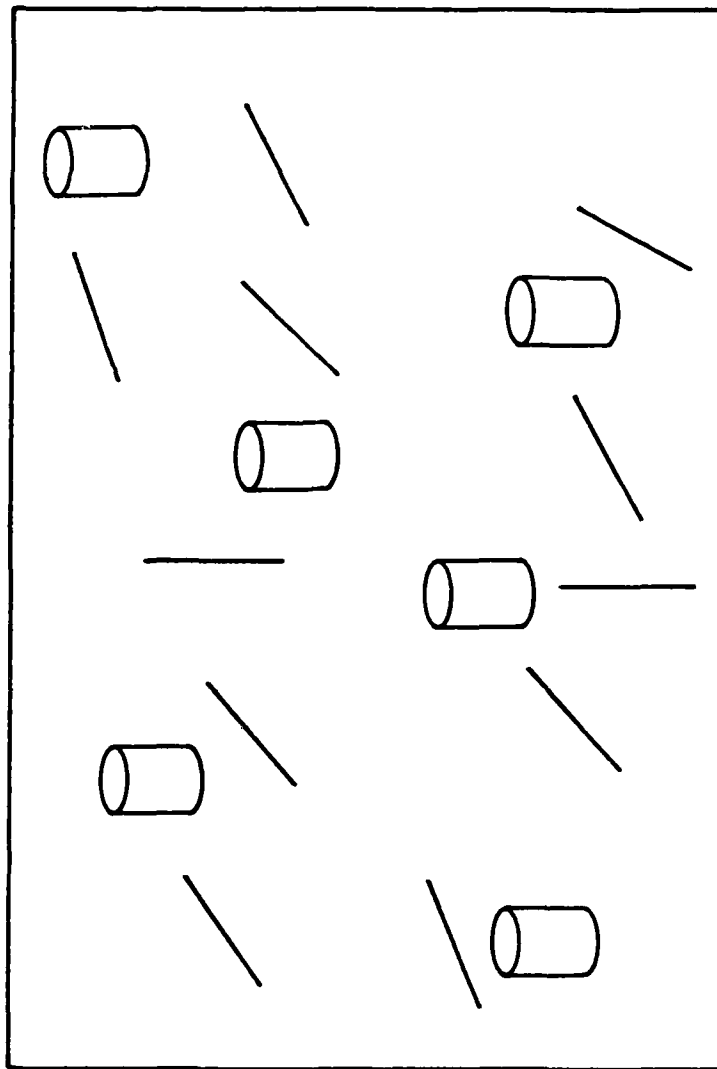USE AS MANY VIEWGRAPHS AS YOU WISH. EACH GROUP WILL PRESENT THEIR RESULTS.

VG 742/IE-5

EXERCISE

ALSO, YOUR DESCRIPTION MUST BE CLEAR ENOUGH FOR ANYONE IN THE CLASS TO BUILD THE SYSTEM

FROM ITS PARTS IN ONE MINUTE.

VG 742/IE-6

EXERCISE (PAGE 3 - ONLY GROUP B HAS THIS)

ALSO, YOUR DESCRIPTION MUST BE CLEAR ENOUGH FOR ANYONE IN THE CLASS TO BUILD THE SYSTEM
FROM ITS PARTS EVERY TIME.

VG 742/IE-7

EXERCISE (PAGE 3 - ONLY GROUP C HAS THIS)

ALSO, YOUR DESCRIPTION MUST BE CLEAR ENOUGH FOR ANYONE IN THE CLASS TO BUILD THE SYSTEM
FROM ITS PARTS.

EXERCISE (PAGE 3 - ONLY GROUP D HAS THIS)

ALSO, YOUR DESCRIPTION MUST BE CLEAR ENOUGH FOR ANYONE IN THE CLASS TO BUILD THE SYSTEM
FROM ITS PARTS AS SHOWN IN FIGURE A OR FIGURE C.

FIGURE C.

VG 742/IE-9
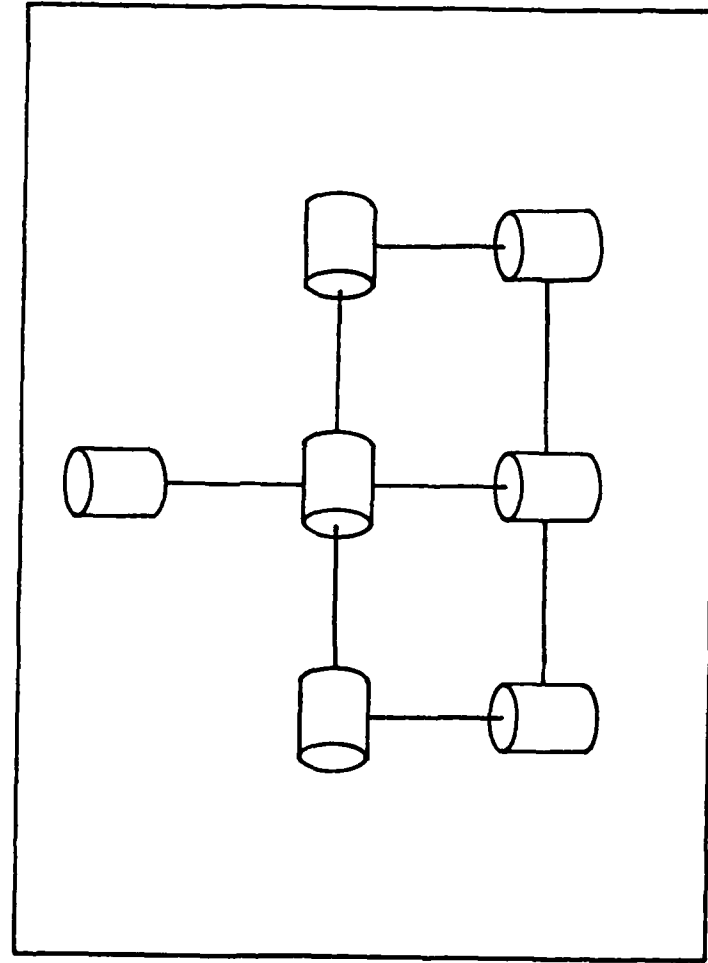
POINTS TO COVER IN THE SUMMARY:

- UNDERLYING PURPOSE OF EACH GROUP

- RELATIONSHIP OF GOAL TO RESULT (I.E., THE DIFFERENCES)

- WHAT ARE SOME OF THE DIFFERENCES IN THE RESULTS

- SOME OF THE ENGINEERING PRINCIPLES WHICH MIGHT HAVE BEEN USED IN EACH GROUP

AS PART OF THE SUMMARY, THE INSTRUCTOR COULD TRY TO ELICIT THE ANSWERS TO SOME OF THE
ABOVE QUESTIONS TO STIMULATE DISCUSSION. BE SURE TO SUMMARIZE AT THE END.

VG 742/IE-10

EXERCISE 2

INSTRUCTOR:

- LET EVERYONE DO PART 1. THEN HAVE ONE PERSON COME UP AND DESCRIBE ONE
  ORGANIZATIONAL STRUCTURE.

- THEN LET EACH PERSON DO PARTS 2 AND 3. WALK THROUGH YOUR EXPLANATION AS A
  CONSCIOUSNESS-RAISING DISCUSSION.

VG 742/IE-11

PART 1

REVIEW EACH OF THE FOLLOWING THREE ORGANIZATIONAL STRUCTURES,

AND WRITE A PARAGRAPH ABOUT THE POTENTIAL PROBLEMS OF THE BOSS.

VG 742/IE-12

VG 742/IE-14
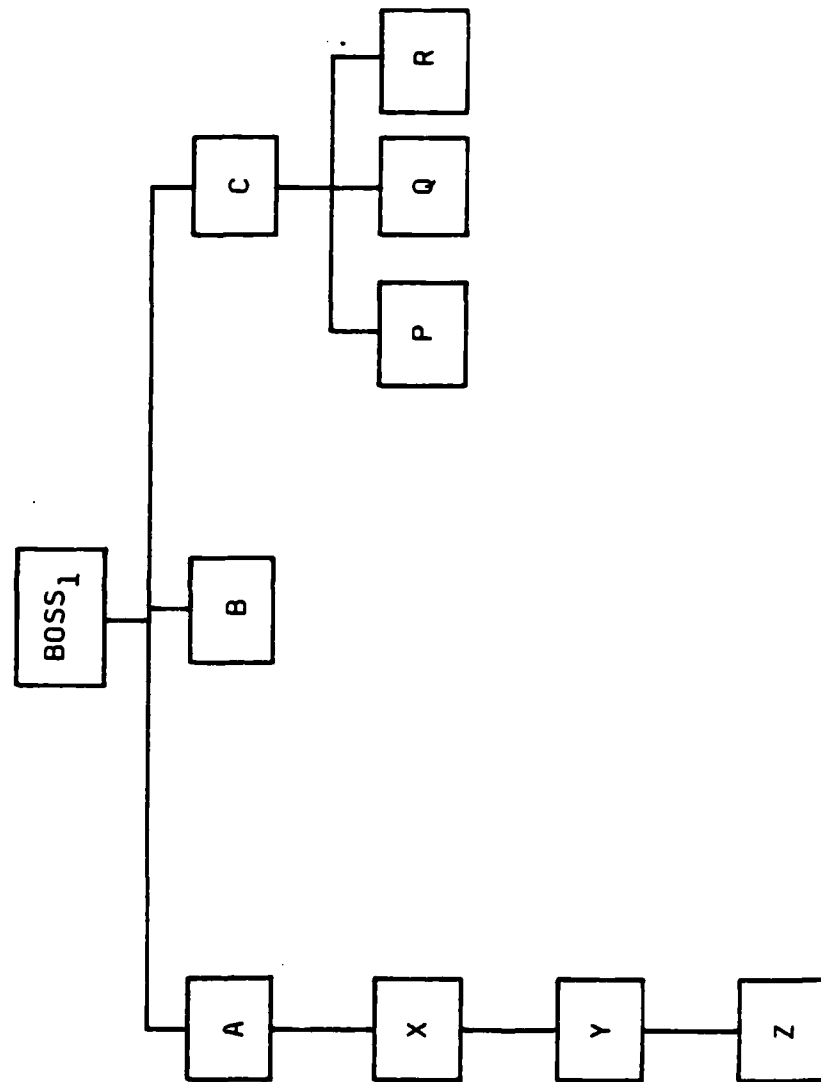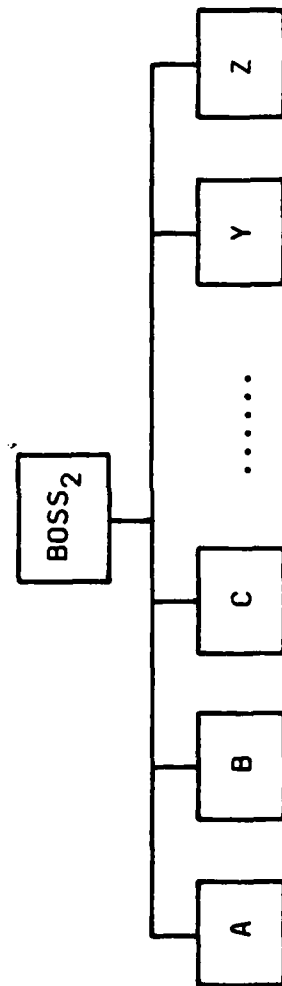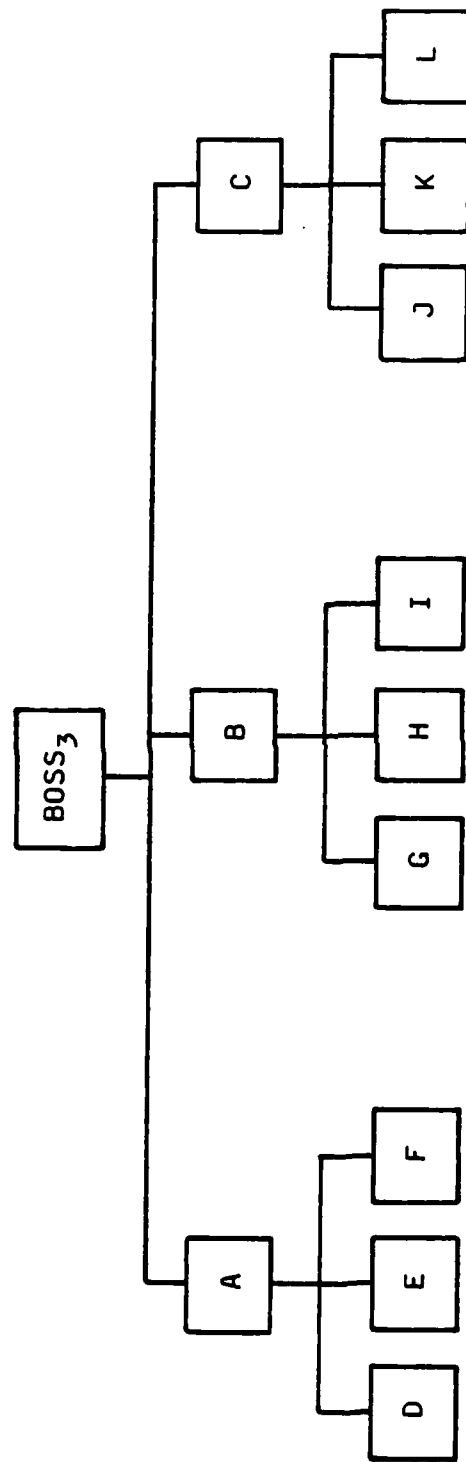
PART 2

NOW READ THE FOLLOWING SUMMARY OF STRUCTURED DESIGN.

- DOCUMENTATION TECHNIQUES. STRUCTURED DESIGN INCLUDES GRAPHIC TOOLS WHICH EMPHASIZE THE STRUCTURAL, OR HIERARCHICAL, ASPECTS OF A SYSTEM RATHER THAN THE PROCEDURAL (LOOPS AND DECISIONS) ASPECTS.

- THEORY. STRUCTURED DESIGN HELPS DISTINGUISH BETWEEN "GOOD" SYSTEMS AND "BAD" SYSTEMS -- AT THE MODULE LEVEL.

- HEURISTICS. STRUCTURED DESIGN INCLUDES RULES OF THUMB WHICH ARE USEFUL WHEN EVALUATING THE "GOODNESS" OF A PARTICULAR DESIGN -- BUT WHICH SHOULD NOT BE FOLLOWED RELIGIOUSLY.

- DESIGN STRATEGIES. STRUCTURED DESIGN ALSO CONSISTS OF VARIOUS DESIGN "STRATEGIES" WHICH ALLOW US TO SYSTEMATICALLY DERIVE "GOOD" SOLUTIONS TO COMMON TYPES OF DATA PROCESSING PROBLEMS. (TOP-DOWN DESIGN COULD BE THOUGHT OF AS ONE SUCH STRATEGY, THOUGHT IT IS USUALLY CONSIDERED LESS USEFUL THAN SOME OF THE OTHER ONES THAT ARE AVAILABLE.)

- IMPLEMENTATION STRATEGIES. STRUCTURED DESIGN INCLUDES THE QUESTION OF "IMPLEMENTATION STRATEGIES:" GIVEN THAT WE HAVE A GOOD DESIGN, IN WHAT ORDER SHOULD WE CODE AND IMPLEMENT THE MODULES?

VG 742/IE-17

WRITE A PARAGRAPH ABOUT HOW THE THREE DIFFERENT ORGANIZATIONAL
STRUCTURES CAN BE LIKENED TO SOFTWARE STRUCTURES ...

VG 742/IE-19
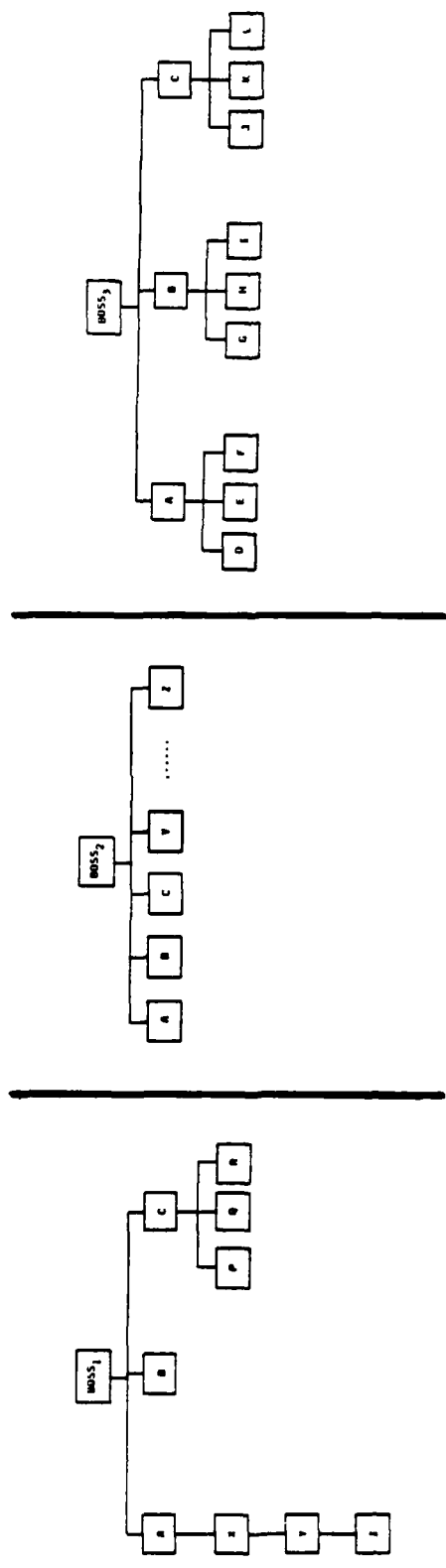
INSTRUCTOR NOTES

TO ILLUSTRATE THE PHILOSOPHY OF STRUCTURED DESIGN, PUT YOURSELF IN THE POSITION OF A MANAGEMENT CONSULTANT. SUPPOSE THAT YOU WERE ASKED TO RENDER AN OPINION ON THE FIRST COMPANY. WHAT WOULD YOUR REACTION BE? MOST LIKELY, YOU WOULD COMMENT THAT VICE-PRESIDENT A, AND MANAGER X, AND MANAGER Y ALL HAVE TRIVIAL JOBS -- SINCE THEIR RESPONSIBILITY SEEMS TO CONSIST SOLELY OF MANAGING ONE SUBORDINATE. BEING A CYNIC, YOU WOULD PROBABLY SUGGEST THAT ALL OF THE WORK IN THAT DEPARTMENT IS BEING DONE BY Z, AND THAT ALL OF THE MANAGERS SHOULD BE FIRED!

SIMILARLY, SUPPOSE YOU WERE ASKED TO EVALUATE THE SECOND ORGANIZATION CHART. WHAT WOULD YOUR REACTION BE? CHANCES ARE THAT YOU WOULD PREDICT TROUBLE: THE BOSS IS A GOOD CANDIDATE FOR AN ULCER OR A HEART ATTACK; AT THE VERY LEAST, ONE WOULD EXPECT THE BOSS TO MAKE A NUMBER OF MISTAKES -- SIMPLY BECAUSE HE HAS TOO MANY PEOPLE TO MANAGE.

FINALLY, SUPPOSE YOU WERE SHOWN THE THIRD ORGANIZATION CHART. THIS LOOKS MUCH MORE REASONABLE! EACH MANAGER HAS A REASONABLE NUMBER OF IMMEDIATE SUBORDINATES -- A REASONABLE SPAN OF CONTROL -- AND THE ENTIRE ORGANIZATION SEEMS PROPERLY "BALANCED." WHILE THERE MAY BE OTHER PROBLEMS IN THIS COMPANY, AT LEAST THE "ARCHITECTURE" INDICATED BY THE ORGANIZATION CHART IS REASONABLE.

NOTE THAT THIS DOES NOT MEAN THAT ALL GOOD COMPANIES MUST HAVE EXACTLY THREE VICE-PRESIDENTS. NOR ARE WE SUGGESTING THAT PERFECT SYMMETRY IS REQUIRED: JUST BECAUSE VICE-PRESIDENT A HAS THREE IMMEDIATE SUBORDINATES, WE DO NOT SUGGEST THAT VICE-PRESIDENT B MUST ALSO HAVE THREE IMMEDIATE SUBORDINATES. ALL WE ARE SAYING IS THAT THE FIRST TWO COMPANIES SHOW EVIDENCE OF SOME STRUCTURAL PROBLEMS -- AND THAT THE THIRD DOES NOT SHOW SUCH EVIDENCE OF TROUBLE.

WHY DID WE GO INTO THIS EXAMPLE IN SUCH DETAIL? BECAUSE PROGRAM STRUCTURES AND SYSTEM STRUCTURES CAN BE DISCUSSED IN A SIMILAR WAY. THE ORGANIZATION CHARTS MIGHT WELL BE STRUCTURAL REPRESENTATIONS OF THREE DIFFERENT PROGRAMS -- OR THREE DIFFERENT SYSTEMS, SINCE THE DISTINCTION BETWEEN PROGRAMS AND SYSTEMS IS LARGELY ARTIFICIAL AT THIS LEVEL OF ABSTRACTION.

INSTRUCTOR NOTES

THUS, WE SHOULD BE IN A POSITION TO MAKE SOME STRUCTURAL CRITICISM OF THE FIRST
COMPANY. IT CONSISTS OF A TOP-LEVEL "EXECUTIVE" MODULE, WHICH ACCOMPLISHES THE OVERALL
APPLICATION BY CALLING UPON THREE "VICE-PRESIDENT" MODULES. OUR CONCERN, OF COURSE, IS
WITH MODULE A: FROM FIGURE 4.1, WE GET THE STRONG SUSPICION THAT IT CONSISTS OF A
SINGLE INSTRUCTION -- A SUBROUTINE CALL TO MODULE X. SIMILARLY, WE SUSPECT THAT MODULE
X CONTAINS ONLY ONE INSTRUCTION: A CALL TO SUBROUTINE Y. AND WE SUSPECT THAT MODULE Y
IS A ONE-INSTRUCTION MODULE THAT DOES NOTHING BUT CALL MODULE Z. MODULE Z, WE SUSPECT,
IS WHERE ALL THE WORK IS DONE.

ALL OF THIS MUST BE KEPT IN A CERTAIN PERSPECTIVE. WE SUSPECT THAT MODULES A, X, AND Y
ARE TRIVIAL -- BUT WE DON'T REALLY KNOW UNLESS WE LOOK AT THE CODE. AND WE RECOGNIZE
THAT THERE IS NOTHING DISASTROUSLY WRONG WITH HAVING A SERIES OF ONE-INSTRUCTION
SUBROUTINES WHICH DO NOTHING BUT CALL A LOWER-LEVEL MODULE. IT'S JUST THAT SUCH A
STRUCTURE IS ... WELL, WHAT SHOULD WE CALL IT? TRIVIAL? BUREAUCRATIC? INEFFICIENT?
ALL OF THESE SUGGEST THAT THERE IS PROBABLY A BETTER ALTERNATIVE TO THE FIRST
ORGANIZATION.

THE SECOND ORGANIZATION REPRESENTS THE OPPOSITE EXTREME: AN EXCESSIVE SPAN OF CONTROL.
WE SHOULD BE CONCERNED ABOUT IT IN A PROGRAM ENVIRONMENT FOR THE SAME REASONS THAT IT
CONCERNS US IN A MANAGEMENT ENVIRONMENT: EXCESSIVE COMPLEXITY. OUR BOSS MODULE
PROBABLY HAS TOO MANY LOOPS, TOO MANY DECISIONS, AND TOO MUCH "MANAGEMENT LOGIC" -- TOO
MUCH, THAT IS, TO BE PROPERLY UNDERSTOOD BY EITHER THE MAINTENANCE PROGRAMMER OR THE
DEVELOPMENT PROGRAMMER.

WHAT WE HAVE JUST ILLUSTRATED IS A "HEURISTIC" -- A ROUGH RULE OF THUMB THAT SHOULD BE
USED AS A GUIDELINE, BUT WHICH SHOULD NOT BE INTERPRETED AS A RELIGIOUS RULE. THE
PARTICULAR HEURISTIC THAT WE SAW IN ALL ORGANIZATIONS IS KNOWN AS "SPAN OF CONTROL" --
A PHRASE BORROWED FROM THE MANAGEMENT FIELD.

VG 742/IE-21

END

FILMED

8